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INSTRUCTIONAL SYSTEMS DEVELOPMENT: CONCEPTUAL ANALYSIS AND COMPREHENSIVE BIBLIOGRAPHY

HUMAN FACTORS LABORATORY
NAVAL TRAINING EQUIPMENT CENTER
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INSTRUCTIONAL SYSTEMS DEVELOPMENT:
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February 1976

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This report constitutes a first step in improving the state-of-the-art of [in]structional systems development (ISD). It contains a bibliography of abou[t] 4,000 entries divided into the following sections: instructional systems [devel]opment/systems approach to training, evaluation, methodology selection, me[dia] selection, programmed instruction/computer assisted instruction, task anal[ysis], job analysis, task taxonomy, specific behavioral objectives, sequencing, instructor training, educational management, cost effectiveness, innovatio[n], educational technology, human engineering, simulation, and systems (cont'd)

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This report also presents a conceptual analysis of ISD, a process which is also known as: the systems approach to training (SAT), systems engineering of training (SET), training situation analysis (TSA), and the design of instructional systems (DIS). The related literature, dating from 1951 to the present, indicates the state-of-the-art to be unsettled. Over 100 ISD manuals are available which contain fundamental disagreement on the most basic aspects of course design. None of the manuals have been empirically validated. In an effort to understand the present state of affairs with respect to ISD, its history was researched. Its evolution was traced from its beginnings in systems analysis, to the systems analytic approach to training, to the proceduralized systems approach to training, which is now known as ISD. The factors which affected this evolution, the current state-of-the-art, and the major questions which remain unanswered are discussed.

PREFACE

The authors would like to express heartfelt gratitude to: Dr. Alfred F. Smode and Mr. Eugene R. Hall of the Training Analysis and Evaluation Group (TAEG) for historical information on the Systems Approach to Training and for their insights on what really happens during training program design; Dr. Richard Braby and Ms. Karen Lam of TAEG for lending their expertise and libraries on media selection and instructor training; Dr. Robert Sugarman of the Calspan Corporation for bringing to our attention numerous sources of information; Lieutenant Colonel Charles Brown, Lieutenant Colonel Thomas Rush and Major Roy Baker of the United States Air Force for making available the wealth of practical knowledge and experience in instructional systems development of the Air Force; and Dr. Gilbert Ricard of the Naval Training Equipment Center for helping refine our conceptual analysis of ISD (Section 1).

Special thanks are also due to Ms. Billie Campbell of the Naval Training Equipment Center's Technical Library for locating and obtaining numerous hard-to-find volumes, and to Ms. Joyce DeNatale and Mrs. Mickey Shore for typing this report.

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SECTION I

INSTRUCTIONAL SYSTEMS DEVELOPMENT: A CONCEPTUAL ANALYSIS

Background

In late 1974, an attempt was undertaken to define the state-of-the-art of the Systems Approach to Training (SAT). This task, which was originally envisioned as a straightforward literature review, was to serve as the design basis for a research program aimed at expanding available SAT technology. However, preliminary work indicated that the size and complexity of the relevant literature, and therefore the scope of the planned project were considerably larger than anticipated. It was found for example, that over 100 SAT manuals had been published between 1960 and 1975. The problem of analyzing the literature was exacerbated by an abundance of idiosyncratic, loosely defined terminology which proved to be the source of a great deal of confusion. SAT, for instance, is referred to by a variety of alternative appellations including: the Systems Engineering of Training (SET), Training Situation Analysis (TSA), the Developmental Approach to Training (DAT), the Design of Instructional Systems (DIS), and most recently, Instructional Systems Development (ISD).

Differences among available formulations of the SAT concept range from superficial variations in terminology to fundamental variations in philosophy. The basic issue on which disagreement exists is the degree to which the instructional design process can be reduced to a linear sequence of generally applicable, prescriptive procedures. The positions that have been espoused range from Eckstrand's (1964) statement that the design of instruction is primarily an art, to the hypothesis that course design can be reduced to a series of well defined procedures which can be carried out by untrained personnel.

The size of the SAT literature, the complexity of the concept, and the controversy which surrounds it, serve to emphasize the need for adequately assessing the state-of-the-art of SAT before embarking on further attempts to expand it. Heeding Santayana's warning that those who are not aware of the past are condemned to repeat it, this bibliography was compiled as a first step in assessing the state-of-the-art. The bibliography was designed to allow researchers, developers and appliers of SAT to enhance the effectiveness of their future efforts by taking greater advantage of the work that has already been accomplished.

The Problem of Definition

The central issue in selecting the content and organization of the bibliography was to define the "systems approach to training" or equivalently "instructional systems development." Of the dozens of definitions contained in the SAT manuals and in the related literature, none have attained widespread acceptance. Campbell (1971) points out that a major problem with the available definitions is that they do not indicate how their particular methodology differs from other SAT methodologies or from traditional ways of

developing training programs. The present state of affairs is characterized by general acceptance of the terms "SAT" and "ISD" together with widespread disagreement as to what the terms mean. This confusion over the nature of SAT is primarily a result of three factors: lack of terminological standardization, problems associated with educational innovations, and the evolutionary nature of the SAT concept. Each of these will now be discussed in detail.

(1) Lack of terminological standardization

Analysis of similarities among existing SAT manuals indicates a high degree of overlap in the terminology used. Almost all of the manuals use the terms: task analysis, behavioral objectives, methodology, media selection, sequencing, objective performance measurement, criterion referenced testing, individualized instruction, and quality control. The use of a common terminology creates the initial impression of high content similarity among the manuals. However, closer inspection of the operational definitions given to these terms shows this impression to be mistaken. The following example is illustrative.

Virtually, all of the SAT manuals use the term "task analysis" but the operational definitions of task analysis provided by the manuals differ both in content and in degree of detail. While some manuals leave much to the discretion of the analysts, others are so specific as to provide a form which need only be completed by the analyst. Some require all skills to be broken down into hierarchical categories such as role, duty and activity, or job, task, and element; others provide little or no structure as to the number or the types of categories to be used. Some require each task to be classified as psychomotor, cognitive or affective; others rate each task on each of these categories; still others ignore this breakdown. The task information called for varies among manuals but usually includes some of the following: criticality, frequency, initiation and completion cues, degree of judgment required, preceding and subsequent tasks, etc.

SAT manuals generally provide only one procedure for task analysis. When alternative procedures are not provided, the assumption is made that the method given is universally applicable. This assumption is not warranted by the literature on task analysis. The Gilbreths, in their pioneering, turn of-the-century work on improving industrial efficiency, developed the first formalized task analytic methodology. Their procedures were useful in time and motion studies on production line tasks. However, in the 1950's, R. B. Miller found that the Gilbreths' procedures did not allow for the identification of human attributes used in complex tasks (Swain, 1962). Miller developed a methodology entitled "task-demands analysis" because he believed that existing methods did not provide adequate data concerning the demands which tasks make on the operator. Since 1960, the number of available task analytic methodologies has risen dramatically. A number of theorists, after reviewing this state of affairs, have concluded that no single method of task analysis can be generated which is valid in all circumstances (Gustafson, Honsberger, and Michelson, 1960; Folley, 1964; DeGreen, 1970; Rankin, 1974).

The degree to which task analysis can or should be proceduralized is controversial. The trade-off is that although higher degrees of proceduralization result in narrower ranges of application, they may permit the use of

less qualified, less costly analysts. DeGreen's (1970) analysis of this problem led him to conclude that: (a) reduction of task analysis to a routine checklist procedure results in "a deluge of useless data"; (b) task analysis must always be viewed as a means and not as an end; and (c) the usefulness of task analytic data is a function of the degree of expertise of the analyst.

Most SAT manuals have failed to inform the user: of the controversies that have been described above, of the existence of alternative methodologies, of the need to modify given techniques to fit specific circumstances, or of the experience, training and skills necessary to perform valid task analysis. The failure to provide this information has prevented users from the benefit of the experience of others as described in the literature, and may have caused them to acquire a naively simple understanding of task analysis.

Although the example used here is "task analysis," a similar presentation could be made concerning each of the terms shared by the majority of SAT manuals: behavioral objectives, media selection, methodology selection, criterion referenced testing, objective performance measurement, sequencing, quality control, etc. Research and analysis are needed to determine for each of these concepts, the degree to which proceduralization can be achieved, the generality of those procedures, and the skills necessary to apply them.

(2) The problems of educational innovations

The second factor contributing to the confusion concerning the nature of SAT has been its emergence as an educational innovation. Students of the history of education have long been aware that the courses which educational innovations take are shaped by factors other than their inherent advantages and limitations. Campbell (1971) stated that educational innovations have historically followed a predictable life cycle, and constructed a three-stage model of that process. In the first stage, a new technique appears and develops a large following of advocates who claim to have successfully applied the technique. The second stage consists of numerous modifications of the basic technique. The third and final stage in the life cycle of educational innovations is the appearance of criticism by a few vocal opponents, which grows into an inevitable backlash. According to the model, this criticism does not serve to stimulate improvement of the technique, but to stimulate the development of a new technique. At that time, the cycle starts anew.

Although Campbell's model is primarily descriptive, Milsum (1968) presents a phenomenom called the "bandwagon effect" which helps explain the model. The bandwagon effect serves to transform researchable hypotheses (educational innovations) into political entities, thereby triggering the mechanism which leads to the innovation's downfall. The mechanism works as follows. As the number of researchers, developers, theorists, administrators, laboratories, schools, etc., who have vested interest in the innovation grows, the resistance to critical examination of the innovation and to the consideration of alternatives also grows. In addition, claims are made for

the innovation by those with vested interest which are unreasonably optimistic. In this way, the innovation attains the reputation as a "panacea", that is, as a widely applicable technique which promises extremely high pay-offs for relatively small inputs. One reason for this occurrence is that timidity concerning possible R&D pay-offs is not conductive to success in the competition for research and development funds. A second reason is that it is more prestigious, more conducive to advancement, and more fun to be associated with the development of a highly visible technique which has the possibility of revolutionizing the educational community.

The process by which the innovation attains the reputation of a panacea has an unwanted side effect. The greater the number of people who attempt to use innovation based on unfulfillable promises, the greater the number of people will be who are disappointed by it. As this number grows, the criticism and backlash predicted by Campbell's model occur and eventually result in the downfall of the innovation.

The history of education is replete with examples of innovations which have fallen victim to these problems: the teaching machine, programmed instruction, adaptive training, team teaching, microteaching, accountability, the voucher system, behavior modification in the classroom, performance contracting, the "free" school, the "open" classroom, Project Headstart, and others. According to Campbell (1971), SAT is the current innovation, and it too is following the life cycle predicted by his model.

The fact that SAT has been touted as a panacea and has fallen victim to the bandwagon effect was first documented in 1968 by Hartley. He concluded that the SAT literature is "long on persuasion and short on critical self appraisal". He believed this to be the result of overzealousness in attempts to use the new methodology without a clear understanding of what it was supposed to produce. Carter's 1969 article, "The Systems Approach to Education: Mystique and Reality" provides not only a review of the problems created by the bandwagon effect but also a realistic assessment of what can be expected from SAT. Sugarman, Johnson and Hinton (1975) and Montemerlo (1975) provide further data and analysis in these two areas.

Campbell's model and Milsum's description of the bandwagon effect have enhanced our understanding of the state-of-the-art of SAT. The studies referenced in the preceding paragraph have documented the problems accrued by SAT which were predictable from Campbell's and Milsum's work, namely: its transformation into a political entity, the resistance to constructive critical assessment of SAT, and its attainment of an oversold reputation. These studies have also indicated the courses of action necessary to ameliorate the conditions caused by those problems. The first is to prevent the backlash predicted by Campbell's model which is caused by the growing realization that an innovation cannot live up to an oversold reputation. This can only be accomplished by reducing those expectations to realistic proportions. The second course of action is to remove SAT from its status as a political entity, and thereby facilitate constructive criticism and the consideration of alternatives. In order to do this, high-level SAT advocates must be fully advised of both the advantages and the limitations of the concept, and of what has historically happened to educational innovations which

have become entrapped in the political arena. The third and final strategy is to subject SAT to rigorous analytical and empirical investigation in order to further delineate and validate its advantages and limitations. These three courses of action will minimize the political factors which have hindered real progress in advancing the state-of-the-art of SAT.

(3) The evolutionary nature of the SAT process

The third and final factor clouding the definitional issue has been the evolutionary process which SAT has undergone. Historical data collected during the compilation of this bibliography, which can aid in resolving this issue, will now be presented.

(a) Systems analysis

The systems approach to training, SAT, evolved from "systems analysis" (alternatively called "the systems approach") a methodology developed during World War II, to solve problems created by rapidly advancing weapons systems technology. After the war, the methodology was found useful in the solution of problems in a variety of fields. The problems for which systems analysis was found to be appropriate are those which are not solvable using existing procedures, and whose complexity strains human comprehension when initially viewed in their entirety. Systems analysis possesses three main features which make it uniquely powerful tool in solving such problems. The first is the use of an interdisciplinary team of experts to ensure that as much relevant information as possible is brought to bear in solving the problem, and that all aspects of the problem are: (1) identified, (2) considered in terms of their relative importance, and (3) considered from different points of view. The second feature is the use of "models", that is, simplifications of the problem which aid in initially understanding highly complex problems by reducing them to analyzable proportions. The third feature is the design of a unique method for solving the problem which is as systematic as the problem will allow. The interdisciplinary team of experts, which creates and implements this design, retains the right to replace or modify it at any point during the analysis.

Systems analysis does not necessarily result in the "best" solution to a problem. It merely insures that the best qualified people have gathered as much relevant information as possible, and have recommended a solution, which in their judgment, is better than the alternatives. In short, systems analysis produces a "best educated guess." The alternatives to systems analysis in solving problems of the type described above, are: the use of personnel with less than the best qualifications, and/or the consideration of less information than is available. Since systems analysis is the most costly of the alternatives, it is employed only when failure to solve the problem involves sufficient potential danger or loss to warrant the added expense.

(b) Systems analysis applied to training

In the late 1950's, the first attempts to apply systems analysis to the design of training programs were undertaken by the Rand

Corporation (Kershaw and McKean, 1958; Kershaw, 1959) which was responsible for much of the development of systems analysis itself, and by the Human Resources Research Organization (Hoehn, 1960) The HumRRO work was summarized by Crawford at the Naval Training Device Center's Seminar on Human Factors in Military Training (16 March 1961). His presentation included a flow chart describing the systems approach to training as a seven stage process. This flow chart has served as a prototype, both in format and in content, for those which appear in virtually all of the SAT literature which followed.

The early SAT literature drew heavily on the techniques of systems analysis. The design of large scale training programs was viewed by early SAT developers as a highly complex task which could not be accomplished procedurally. SAT provided an alternative to the traditional approach to training program design which relied solely on subject matter experts. Although the training programs developed by such personnel are effective in teaching the desired skills, they are generally not as efficient as they could be if the training program design team had possessed expertise in educational psychology, training technology, and systems analysis. The increased cost incurred in the use of systems analytic techniques by expert training program designers will be more than offset by the increased efficiency of the programs they produced.

The goal of early SAT developers was to generate tools which could aid training program design experts in their day-to-day work. These tools consisted of models, that is, formalized simplifications of methods and techniques which other experts had found useful. These models were intended to be used, modified or ignored, in any particular situation, based on the discretion of the user. They were not intended to relieve him of his responsibility as a decision maker.

(c) The bifurcation

The early 1960's witnessed the emergence of a new technology which greatly affected the evolution of SAT. This new technology was based on the hypothesis that if training program design experts could formalize models of the methods and techniques that made them successful, then laymen could follow these models and produce the same result at lower cost. The main thrust of developmental efforts under this technology has been the production of manuals which attempt to reduce the design of training programs to a linear sequence of procedures which can be carried out by personnel inexperienced in training program design.

This new technology was quite different from SAT. According to SAT, training program development is a complex problem which cannot be solved procedurally, and therefore requires the techniques of systems analysis. According to the new technology, training program development can be accomplished by a layman using a proceduralized manual, thus rendering systems analysis inappropriate. The new technology and SAT are fundamentally at odds both in philosophy and in practice. A great deal of confusion was caused when the new technology, which held that systems analysis (i.e., the systems approach) is inappropriate to training program development, adopted:

the name of SAT, its flow charts, and much of its terminology. To ensure clarity during the remainder of this paper, the original, generic concept of SAT will continue to be referred to as SAT, where the new technology will be referred to as "proceduralized SAT."

(d) The proceduralized SAT manuals

During the mid and late 1960's, the concept of proceduralized SAT attained widespread popularity in both the military and civilian communities. Over one hundred proceduralized SAT manuals were published between 1960 and 1975, mostly by the military. The Navy first entered this field with the development of the Training Situation Analysis (TSA) methodology (Bertin, 1963; Van Albert et al, 1964; Chenzoff and Folley, 1965). The Army began with Project Minerva, an Army Security Agency study which resulted in the Design of Instructional Systems (DIS) manual in 1966. An excellent overview of this project is provided by Tracey, Flynn and Legere (1967). Two other influential manuals of this period were Butler's (1967) Instructional Systems Development (ISD) manual, which was written under Job Corps auspices, and Rundquist's course design manual (1966, 1967, 1970) which was developed at the Navy Personnel Research and Development Center.

Later SAT manuals developed by the armed services include the Army's CONARC REG 350-100-1, Systems Engineering of Training, (1968); the Air Force's Manual 50-2, Instructional Systems Development, (1970); and the Air Force's AFP 50-58, Handbook for Designers of Instructional Systems, (1973). The Army, Navy and Air Force participated in the development of an Interservice ISD manual which was published late in 1975.

These proceduralized SAT manuals subdivide training program development into a number of linear steps which generally include: task analysis, specific behavioral objectives, selection and sequencing of tasks for training, media and methodology selection, development of objective tests, initial course implementation and refinement, and quality control. It is interesting to note that a methodology, similar to the proceduralized SAT manuals of the 1960-1975 era, was in use by the Air Force in the 1940's. The Report of the Training Analysis and Development Conference held at Scott AFB on 22-24 October 1951 describes that methodology, which was called the Developmental Approach to Training (DAT). DAT specifically entailed: task and training analyses, specific objectives, sequencing, objective measurement, quality control, and selection of optimal training methods. It emphasized the "mission approach to training," and the measurement of performance rather than of verbalization. This methodology which predated SAT by over a decade was not tied to systems analysis. The report does not state when DAT was developed, but LtCol Ferguson said at the 1951 conference that he had been using it for 34 years. The report noted that DAT management personnel faced a problem in 1951 which plagues their ISD counterparts in 1975, the lack of uniformity with which their methodology was interpreted and applied. The DAT concept, while similar in many respects to TSA, SAT, ISD, DIS, and SET was not formalized to as great a degree.

The development of proceduralized SAT manuals has continued from the early 1960's to the present. However, little is known concerning the degree

to which these attempts have been successful. The only large scale empirical evaluation of such a manual was carried out by the Human Resources Research Organization at the request of the Army. Ricketson, Shulz and Wright (1970) evaluated the capability of personnel inexperienced in training program development to implement CONARC REG 350-100-1, Systems Engineering of Training. They found that the manual told the user what to do, but not how to do it. As a result, little use was made of current training technology, and the users tended to develop training courses resembling those with which they had been taught. The manual required a great deal of paperwork, 19 major products and 81 subproducts. However, the users often did not know the purpose of much of this documentation and, as a result, often ignored the paperwork after completing it.

The general finding of the evaluation was that the manual, when used by inexperienced training program developers, did not result in efficient training programs utilizing state-of-the-art training technology. In other words, they found that in the case of the CONARC REG 350-100-1, the goal of developing a model of the expert course developer, which would allow a layman to imitate his methods and thus produce similar results at a lower cost, had not been achieved. Of course, the results of this investigation do not imply that all of the proceduralized SAT manuals are ineffective or that they can not be made effective. They do emphasize, however, the need to validate future manuals before implementing them on a large scale. They also indicate the need for further investigation into the question of which portions of training program development lend themselves to proceduralization, the degree of proceduralization which can be realistically expected, and the degree to which the procedures are generalizable across types of training problems.

(e) Revival of the original SAT concept

During the middle and late 1960's, the proceduralized SAT concept generated a great deal of literature. The original, generic concept of SAT, which remained relatively dormant during that period, has been the subject of renewed interest during the 1970's. This is, at least partially, a result of a re-evaluation of the state-of-the-art of educational psychology (Campbell, 1971; Glaser and Resnick, 1972; McKeatchie, 1974), which has concluded that the available theory and empirical evidence on the process of learning and teaching do not support the proceduralization of the training program development process. As McKeatchie (1974) points out, psychologists are much less sure of the "laws of learning" than they were a few years ago.

Recent research under the original SAT conceptualization, which is in agreement with these conclusions, is again attempting to develop methods, models, and techniques which training experts can use, modify or ignore. This reflects a re-emergence of the 1950's belief that development of training is a complex problem, not solvable by proceduralized methods, but requiring the techniques of systems analysis. One area in which this type of work is being carried out is that of the selection of training media. Braby, et al (1975), and Boucher, Gottleib and Morganlander (1973) have produced media selection models which specifically state that their goal is to assist rather than to replace the experienced specialist. Braby, et al (1975) state: "The choosing of an optimal instructional delivery system for various types

of military training objectives remains a subtle and complex decision making task; something that can not be fully proceduralized. Training systems designers who use the TECEP technique must possess expert knowledge of media. The technique will serve as a performance aid in carefully exploring the probable cost and effectiveness of various alternatives, including innovations". With this statement, they have captured the essence of the original and the generic meaning of the systems approach to training.

At present, both the original and the proceduralized concepts of SAT are active. However, since both use the same terminology, each particular piece of literature must be read to determine the conceptualization of SAT under which it falls. The SAT literature has been a prime source of confusion concerning the nature of SAT. The history of the SAT concept, as it comes to light, should aid in reducing this confusion.

Summary and Conclusions

The voluminous SAT literature produced over the past two decades reveals an underlying confusion concerning the nature of SAT. The same terms are used to refer to different methodologies, thereby yielding the illusion of a greater degree of agreement than actually exists. The empirical studies needed to validate the various methodologies and to evaluate the real differences among them, have not been accomplished. Educational historians have noted that this is a typical occurrence in the life-cycle of educational innovations. A bandwagon effect takes hold and transforms the innovation into a political entity, suppressing empirical validations, constructive criticism, and the consideration of alternatives. To further complicate matters, two opposing schools of thought as to the nature of SAT have evolved, coexisted, and gone under the same name. The three issues, terminology, political problems, and the evolution of the concept, which have caused much of the existing confusion, have been identified and discussed here as a first step toward defining the state-of-the-art of SAT.

A great deal of research is needed to further refine and articulate the SAT concept. To be effective, it must include empirical investigations. Failure to do so in the past has resulted in the development of over one hundred proceduralized SAT methodologies, none of which has been determined to be more effective than any of the others. Empirical validations of SAT methodologies are expensive, time consuming and difficult to control. Therefore, the necessary experimentation must be preceded by analysis to insure that the methodologies to be evaluated are as complete, as internally consistent, as continuous with existing knowledge, and as potentially useful as possible. This bibliography was compiled to aid in these analytic endeavors. Through comprehensive literature surveys, SAT developers can insure that fullest advantage has been taken of existing technology, that previous mistakes are not being repeated, and that existing wheels are not being reinvented.

The fundamental issue requiring resolution is the nature of SAT. The original concept holds that training program development cannot be proceduralized, and that it is therefore the proper domain of the expert training program designer. The second SAT concept is that training program design is proceduralizable, and that manuals can be developed which are usable by personnel less competent and less costly than the expert to produce equally effective training programs. The resolution of this issue created by these two conflicting concepts, probably lies in their synthesis. The fully proceduralized SAT concept has no basis in existing psychological theory and research. Yet experience with it has shown that laymen can be productive in some aspects of training program design. The original SAT concept, which relies on the expert, provides no information on the particular skills necessary to qualify someone as an expert. Hard data is needed to determine what skills are necessary and the degree of proficiency to which each is required for the accomplishment of the various steps of training program development.

The original concept of SAT has resulted in the development of models of these steps, but the question of generalizability is left to the expert.

The proceduralized SAT concept has also resulted in models (manuals) but with no stated limits of generalizability. The former is not desirable; the latter is unacceptable. Hard data is needed to determine which aspects of training program development can be proceduralized, the degree to which they are generalizable. When these questions are answered, training programs can be developed to bring individuals to the necessary degree of competence in the skills needed to use the models correctly. The ambiguities within each of the two SAT conceptualizations must be resolved in order to allow SAT research to proceed more rapidly.

SECTION I - Organization of the Bibliography

Documents falling into more than one category are referenced in each of the relevant sections. Unauthored military documents are found at the end of each section. The bibliography has been divided into eighteen sections, each covering a topic important to training program development. The topics include those which are considered by the proceduralized SAT manuals, such as: task analysis, specific behavioral objectives, sequencing, media selection, methodology selection, and evaluation. Also included are other topics which must be considered in the design of efficient training programs but which are neglected by the proceduralized SAT manuals: instructor training, instructional management, cost, human engineering, simulation, innovation and educational technology. The remaining sections are: ISD/SAT, PI/CAI, job analysis, task taxonomy and systems analysis/operations research. A brief description of each section follows:

SECTION II - Instructional Systems Development (Systems Approach to Training)

The general references, manuals, articles, etc., on SAT under all of its names (ISD, DIS, DAT, TSA, SET, SAT) are listed together with: subject-matter-specific SAT manuals, SAT final reports, analytic evaluations of the SAT concept, and the single empirical evaluation of a SAT manual. All SAT references which could be found are included. They date from 1951 to 1975. Perusing this section will aid the reader in obtaining a perspective on the SAT literature, its size, its chronology, its authorship and its content.

SECTION III - Evaluation

Evaluation permeates every aspect of training program design. The training technologist is called upon to evaluate schools, programs, teachers, students, materials, media, and concepts. The various types of evaluation including quality control and the factors which affect them are referenced in Section III. Although statistics is an integral part of evaluation, it would have been unwieldy to include the entire statistical literature in this section. Thus only a few standard texts have been included. Statistical questions arising during training program design which are not covered in a basic text such as Hays (1963) should be referred to a competent statistician.

SECTION IV - Methodology Selection

Traditionally, course developers have relied on three methods, the lecture, the conventional textbook and practice with the operational device,

for all of training. Although such programs are usually effective, they are probably not as efficient as they could be. One focus of SAT developmental efforts has been to increase training efficiency by tailoring the teaching methods used in a course to the subject matter and to the specific objectives of the course. Although most of the proceduralized SAT manuals include a "model", that is, a set of rules for accomplishing this, none have been validated.

SECTION V - Media Selection

Efforts to increase training efficiency have also included the selection of media to be used based on the content and objectives of a course. As with methodology selection, the ultimate media selection device would be a catalogue which specifies the optimal media, given the parameters of the training task. Although most proceduralized SAT manuals have included such catalogues, none have been validated and none have been widely accepted. Sugarman, Buckenmeier and Johnson (1975) state that such catalogues can not be made workable at this time, because the necessary information is not available. Eckstrand (1964) DeGreen (1970), Braby et al, (1975) and Montemerlo (1975) arrived at the same conclusion.

SECTION VI - Programmed Instruction and Computer Assisted Instruction

Although programmed instruction and computer assisted instruction are instructional methods, a separate section was allocated to them because of the vast literature they have produced. The most comprehensive bibliography on programmed instruction and computer assisted instruction is that of the Entelek Corporation. However, since it is a subscription service and may not be readily available to the reader, Section VI is included.

SECTION VII - Task Analysis

There is universal agreement in the SAT literature that task analysis is necessary. However, there is little agreement as to what a task analysis is. No satisfactory answers exist to the following questions. Can task analysis be proceduralized? If so, to what degree? How generalizable would those procedures be? What skills must a good task analyst have? How can one differentiate between a "good" task analysis and a poor one? If two well qualified task analysts independently analyze the same task, what degree of commonality would their output have? How does one transition from task analytic data to the development of the training materials? Section VI contains the references on all aspects of task analysis except for task taxonomy (Section IV) and job analysis (Section VIII).

SECTION VIII - Job Analysis

The difference between job and task analysis is a frequent source of confusion among newcomers to the training community. The two differ in purpose, process, and product. Job analysis is a managerial tool for allocating tasks to slots (positions, billets), and results in a job description. Such documents contain information irrelevant to training and do not contain sufficient information on which to base a training program. Task analysis

is concerned with the detailed description of the subtasks of a given task area with the heirarchical relationships among them. The areas of job and task analysis are closely intertwined and the reader interested in either will benefit from both Sections VII and VIII.

SECTION IX - Task Taxonomy

Having determined the content of a training program, the job of the course designer is to determine how to teach it most efficiently. In other words, methods, media and sequences which are most appropriate to the course content must be chosen. The characteristics used to describe course content are known as the "task taxonomy Eckstrand (1964) stated that until a viable task taxonomy which relates types of course content to media and methods becomes available, course design will be more of an art than a science. To date, no such taxonomy is available. In spite of the central role of task taxonomy in training technology, very little research effort has been expended to further the state-of-the-art. The high risk associated with the development of generally applicable taxonomies has caused researchers to concentrate their efforts in the generation of taxonomies specific to certain fields, such as leadership and maintenance.

SECTION X - Specific Behavioral Objectives (SBO's)

The state-of-the-art of SBO's is similar to that of task analysis. There is widespread agreement that SBO's are important, yet, most of the important questions concerning them remain unanswered. For instance, although writing SBO's adds to the cost of course design, no empirical evidence could be found concerning the circumstances under which this added cost is counter-balanced by savings accrued through greater training efficiency. Two facts serve to emphasize the importance of answering this question. One is that a great number of effective training programs exist for which explicit SBO's were never written. The other is SBO writers often become "bogged down" in detail. Empirical evidence is needed concerning the point past which increased detail causes more problems than it solves. This would help answer other key questions such as: How can the SBO writer determine when his work is "good enough" (that is, sufficiently complete and in a useful form)? How can a contract monitor, or any one other than the SBO writer, make the same determination? What training and experience qualify a person to write SBO's? Given two qualified SBO writers working independently on the same course, how different will their outputs be? Will it make any difference in the efficiency of the course to be developed?

SECTION XI - Sequencing

The training program designer attempts to sequence instructional events to obtain maximal transfer of training. Perhaps less is known about this process than about any other stage of instructional design. The most obvious and most often used strategy is to base the sequence on the hierarchy of task subtasks developed during task analysis. The fallacies inherent in this approach and the reasons why it should not be adopted as a general rule are discussed in detail by Glaser and Resnick (1972). Unfortunately, neither they nor anyone else provides a viable alternative for general usage.

SECTION XII - Instructor Training

Proceduralized SAT manuals have generally paid little attention to the problems of how to select, train and evaluate instructors. Yet, the most carefully designed training program, especially an innovative program, can not succeed without the support of the instructors who will implement it. With the advent of modern techniques which may run counter to the experience and beliefs of instructors, the adequate preparation of instructors for these innovations is even more important. Unlike other areas of instructional design where design strategies are being used which have no theoretical or empirical basis, more is known about instructor training than is being implemented.

SECTION XIII - Educational Management

The careful preparation of a training program provides the potential for effective and efficient training. The degree to which that potential is achieved depends on how the program is managed.

Careful attention must be paid to student flow, instructor flow, scheduling, maintenance, supplies, and ancillary services. In general, the larger the instructional program, the more important is the management plan. For instance, a pilot training program could not exist without a management plan, while the effectiveness of a short programmed text would not be significantly changed if it was not accompanied by a management plan. The lack of attention to management problems by the procedural SAT manuals indicates that they are intended only for developing instructional programs of the latter type. As can be seen in Section XIII, interest in educational management is increasing.

SECTION XIV - Cost

The primary goal of training designers is to ensure cost-effectiveness, that is, the meeting of all training objectives in the least costly manner. Yet, the determination of training program costs, and the allocation of those costs to specific portions of the program is a difficult task. The generation of meaningful cost estimates is hampered by the fragmentation of monetary responsibility, the variety of accounting procedures used, and political problems. A further deterrent to objective determination of cost savings is the pressure which is often brought to bear on SAT teams to show cost savings. When an existing training program is re-developed (ISD-ed, SAT-ed) its objectives often change, further complicating the measurement of relative costs. Section XIV can provide help to personnel faced with such problems.

SECTION XV - Innovation

The selection of appropriate training methods and media can have side-effects for which the training program designer should be prepared. If the selection includes methods and/or media unfamiliar to the instructors and administrators who will implement the new training program, problems associated with innovation will arise. The requirement to change from

practices which are familiar and comfortable inevitably arouses anxieties. The additional factor of vested interests complicates the problem. The innovative course designer must be a skilled politician if his programs are to be implemented, and more importantly, if his programs will be continued after his involvement ceases. While the bibliography in Section XV does not provide solutions to all of the problems associated with innovation, it can make the reader aware of many of those problems and can indicate how others have attempted to solve them in specific instances.

SECTION XVI - Educational Technology

The professional training program developer is called on to make judgments concerning the relative efficacy of various methods, media, sequences, etc. To do this he draws upon his experience, his training and the experience of others as described in the professional journals. In essence, it is this collective experience which definesthe field of educational technology. A static entity such as this bibliography or a SAT manual is not capable of adequately describing the constantly expanding field of educational technology. Section XVI of this bibliography can direct the reader to summaries of the field published up to now and can lead him to the periodicals which will keep him up-to-date.

SECTION XVII - Human Engineering and

SECTION XVIII - Simulation

The training program developer often faces decisions concerning the use and design of simulators and training devices. In order to do this, he must have a working knowledge of human engineering, the state-of-the-art of simulation hardware, and the translation of training requirements into hardware design. The majority of the inputs of the training program developer will be in this last area. Although there is little theory available to help there is a wealth of empirical data based on past experience which can prove valuable. Sections XVII and XVIII can aid in locating it.

SECTION XIX - Systems Analysis and Operations Research

The field of "operations research" gave rise to "systems analysis" which in turn led to the original conception of the "systems approach to training." The final step in this evolution has been the proceduralized systems approach to training which is also known as instructional systems development (ISD). A knowledge of the precursors of ISD can greatly increase one's understanding of the present state-of-the-art. Section XIX provides the relevant references.

SECTION II

INSTRUCTIONAL SYSTEMS DEVELOPMENT/ SYSTEMS APPROACH TO TRAINING

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SECTION VI

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SECTION VII

TASK ANALYSIS

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SECTION X

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SECTION XI

SEQUENCING

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EDUCATIONAL MANAGEMENT

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SECTION XVIII

SIMULATION

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SECTION XIX

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